SOUTHWEST PENNSYLVANIA ENVIRONMENTAL HEALTH PROJECT

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User Guide
for Radium Monitoring of Surface Water
Using the National Water Quality Portal

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Introduction

The Pennsylvania Department of Environmental Protection (DEP) is charged with the responsibility of monitoring the state's surface water. The intensity of shale gas and oil development has made this responsibility more important than ever. In particular, the movement of radioactive material brought on by shale gas extraction has raised serious public health concerns. Radium and its breakdown elements Ra-226 and Ra-228 are emitted from well pads, contaminate the waste stream, and can make their way into surface water. We hope this guide will allow you to more easily access the information you need.

To skip to directions on how to access radionuclide test results in surface water for your area, go to page 5.

Why Monitor Radium in Surface Water in Southwestern Pennsylvania?

Radioactive compounds naturally exist in Marcellus shale, where oil and gas extraction occurs. Chemicals used in hydraulic fracking react with naturally occurring minerals in the shale, some of which contain radioactive elements. This radioactive material is brought to the surface through drill cuttings and flowback water. Because exposure to radioactive material—including radium, Ra-226, and Ra-228—can cause cancer and other health conditions, we are interested in tracing it.

Research has shown that solid fracking waste, mostly drill cuttings, travel from fracking sites to landfills.[1] There, radioactive compounds can seep into the landfill leachate—the liquid waste that is extracted from landfills. This leachate is taken to water treatment plants in Pennsylvania and discharged into streams and rivers.

With this guide, community members, researchers, and NGOs can more quickly access and understand existing data on radium levels in surface water and public drinking water supplies. This guide answers questions such as:

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[1] Hill, L. A. L., Czolowski, E. D., DiGiulio, D., & Shonkoff, S. B. C. (2019). Temporal and spatial trends of conventional and unconventional oil and gas waste management in Pennsylvania, 1991–2017. *Science of The Total Environment*, *674*, 623–636. https://doi.org/10.1016/j.scitotenv.2019.03.475

- What type of monitoring is being done for radium in Pennsylvania's streams and public water supplies?
- How frequently are tests conducted? Who conducts them?
- When and where has radium been detected? At what levels? When and where has it not been detected?

Surface Water

To investigate radium levels in surface water, streams, and rivers, download data from the [Water Quality Portal](). This portal aggregates regularly required surface water monitoring from several agencies throughout Pennsylvania. However, it does not include special projects or PA DEP initiatives that are outside of regularly required monitoring, such as the TENORM report, bioaccumulation research, sediment sampling, and outflow dredging. To learn about those activities, click the links in the footnotes.[2,3,4]

How Often Are Drinking and Surface Water Radioactivity Tests Conducted?

Surface water, such as that found in a river or stream, is not required to be tested for radioactive contaminants because it is viewed as raw source water that will be treated before it reaches the public as drinking water. Nevertheless, some related sampling has been done by the PA DEP. Previous DEP studies have investigated bioaccumulation in fish and radium levels in sediment near water treatment plant (WTP) outflows. The DEP also completed a study of TENORM (technologically enhanced naturally occurring radioactive material) in 2015.

What Are the Standards for Radium?

The U.S. Department of Environmental Protection (EPA) has set a maximum contaminant level (MCL) for alpha radiation in surface water at 15 pCi /L. For beta radiation, the MCL is 50 pCi/L. Since 2010, over 600 surface water samples have been taken throughout Pennsylvania. Only one sample was over the MCL for alpha, and none have been close to the beta limit, with very few being over 10pCi /L.

[2] http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Sediment%20Sampling%20Pilot%20Study%20Report%20-%20Summer%202011.pdf

[3] http://www.depgis.state.pa.us/emappa/

[4] https://www.dep.pa.gov/Business/RadiationProtection/Pages/TENORM.aspx

Academic Articles for Radium and Chemicals Related to the Fracking Waste Stream

- Good, K. D., VanBriesen, J. M. (2017). Power Plant Bromide Discharges and Downstream Drinking Water Systems in Pennsylvania. *Environmental Science & Technology*, *51*(20), 11829–11838. https://doi.org/10.1021/acs.est.7b03003

- Hill, L. A. L., Czolowski, E. D., DiGiulio, D., Shonkoff, S. B. C. (2019). Temporal and spatial trends of conventional and unconventional oil and gas waste management in Pennsylvania, 1991–2017. *Science of The Total Environment*, *674*, 623–636. https://doi.org/10.1016/j.scitotenv.2019.03.475

- Lauer, N. E., Warner, N. R., Vengosh, A. (2018). Sources of Radium Accumulation in Stream Sediments near Disposal Sites in Pennsylvania: Implications for Disposal of Conventional Oil and Gas Wastewater. *Environmental Science & Technology*, *52*(3), 955–962. https://doi.org/10.1021/acs.est.7b04952

- Swiedler, E. W., Muehlenbachs, L. A., Chu, Z., Shih, J.-S., Krupnick, A. (2019). Should solid waste from shale gas development be regulated as hazardous waste? *Energy Policy*, *129*, 1020–1033. https://doi.org/10.1016/j.enpol.2019.02.016

- Wilson, J. M., VanBriesen, J. M. (2012). Research Articles: Oil and Gas Produced Water Management and Surface Drinking Water Sources in Pennsylvania. *Environmental Practice*, *14*(4), 288–300. https://doi.org/10.1017/S1466046612000427

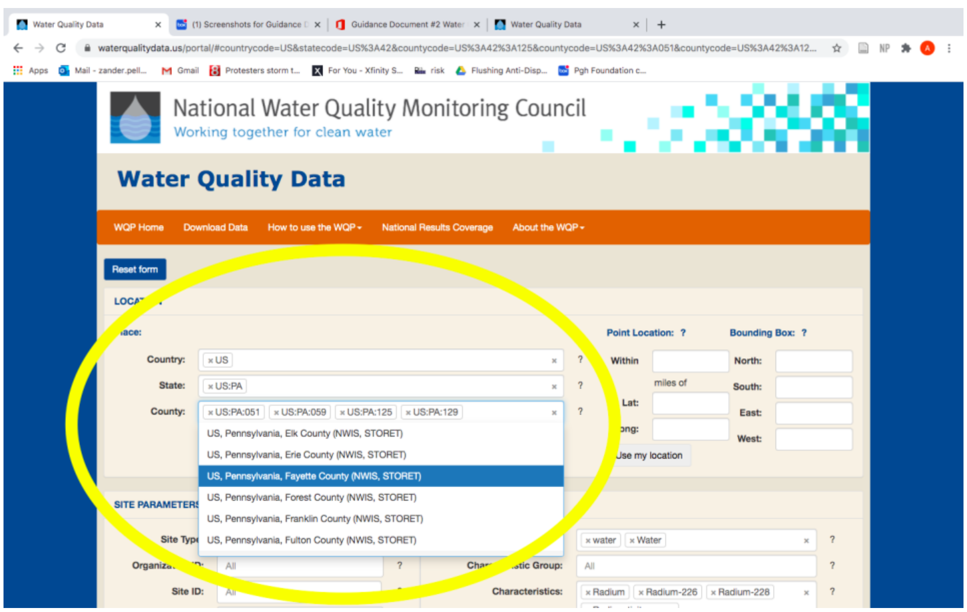
Getting the Data: Surface Water

Follow the steps below to get the radium monitoring test results for surface water in your area.

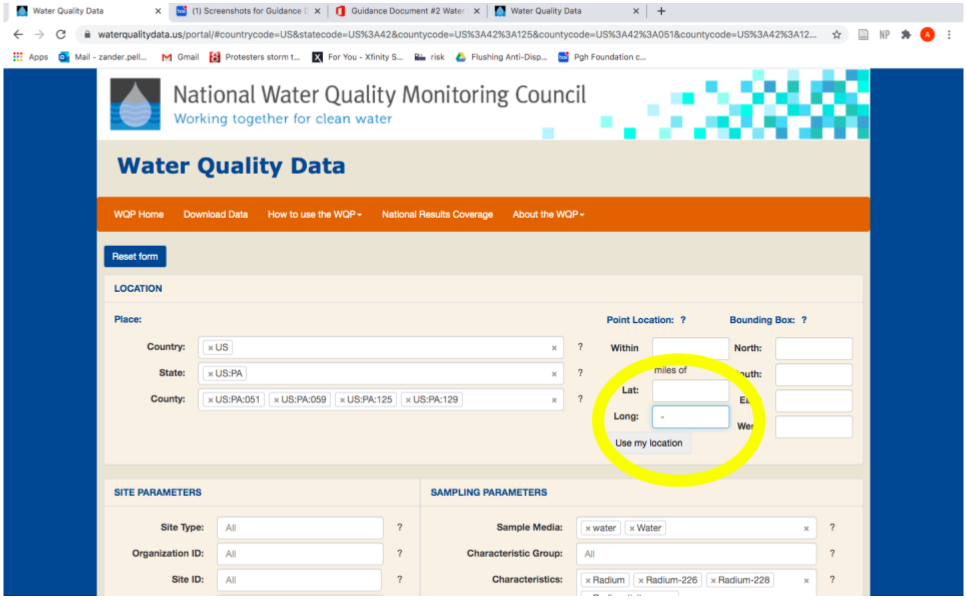
1. Go to the [Water Quality Portal](). This site aggregates monitoring reports for water quality from four different databases that a range of organizations and government entities report to.

   It contains a [step-by-step guide]() produced as a companion to the website. It is a great resource that heavily informed these instructions.

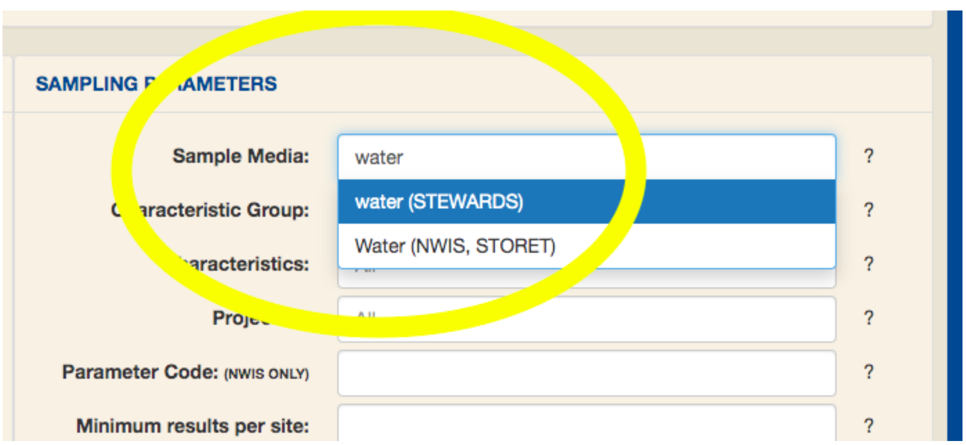
2. Select your location by typing in the country, state, and county boxes. As you type, a dropdown menu will appear. Select your desired location. You can select multiple states and counties.



3. If you are not using “Point location” or “Bounding box” to choose your location, be sure all those cells are empty. Occasionally, the default will leave a dash in the longitude box.

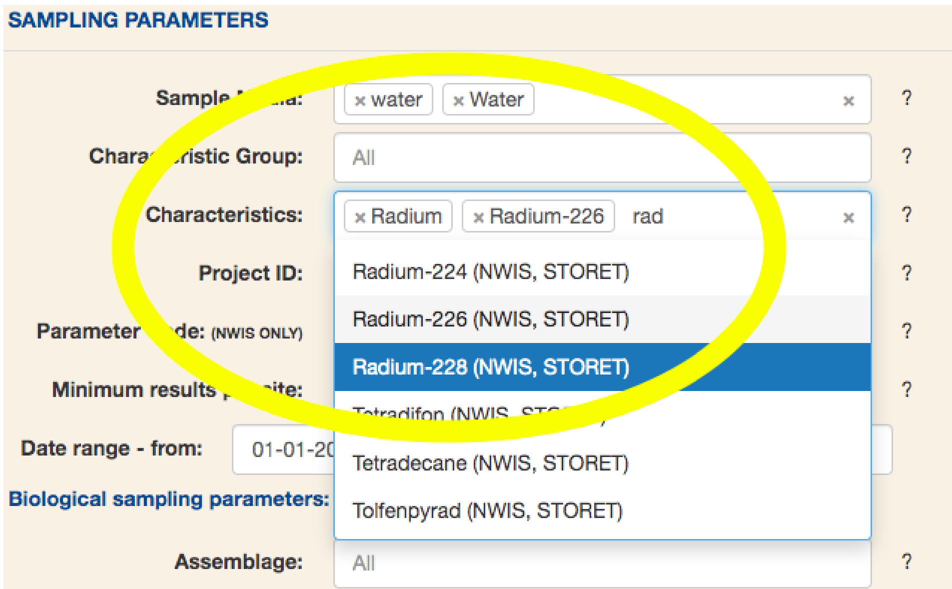


4. Select “water” and “Water” under “Sampling Media.” The lowercase water and capitalized Water draw from different databases. Selecting them both gives you the most data.

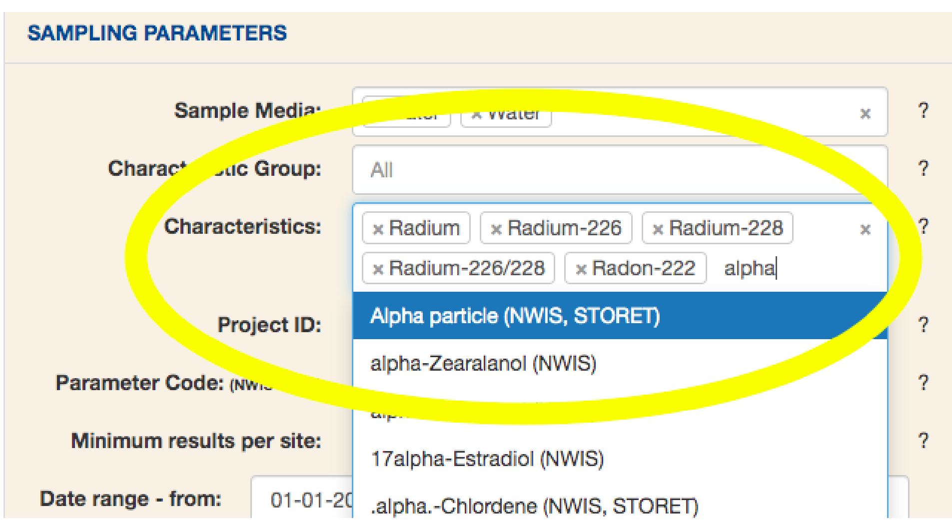


5. Then select the relevant search terms for your area. You will need to begin typing each term, and a dropdown menu will appear. Then select the terms from the list. We recommend the following:

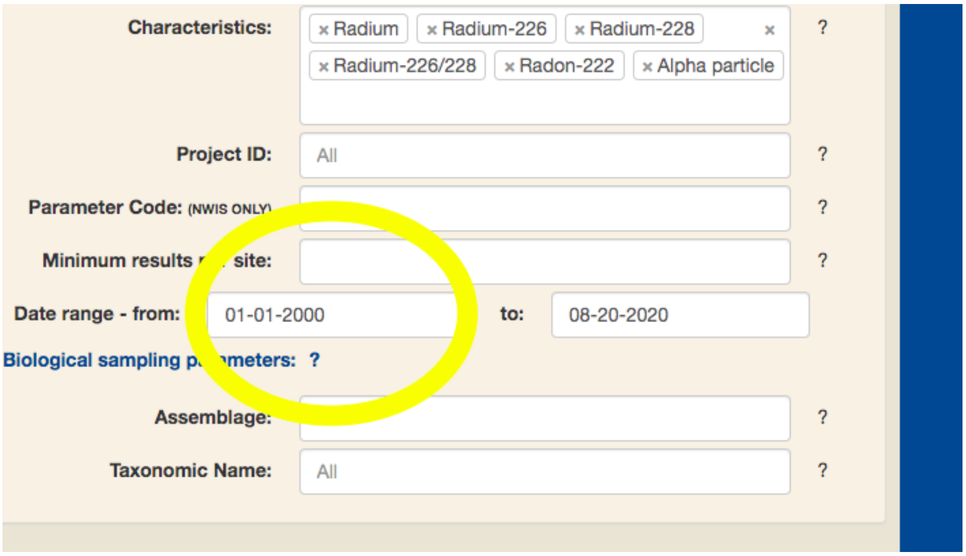
    a. “Radium, Radium-226, Radium-228, Radium-226/228.” These terms reflect common radium isotopes that may be monitored.



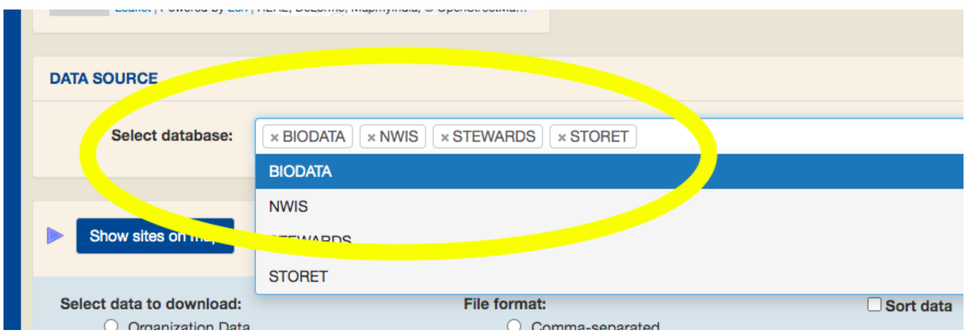
    b. “Alpha particle,” “Radioactivity gross,” “Radium isotopes, Alpha emitting,” and “Adjusted gross alpha activity” are terms that refer to alpha radiation, which is given off by the isotopes above. Organizations frequently use it as a first testing step to determine whether or not a more specific test for radium should be run.



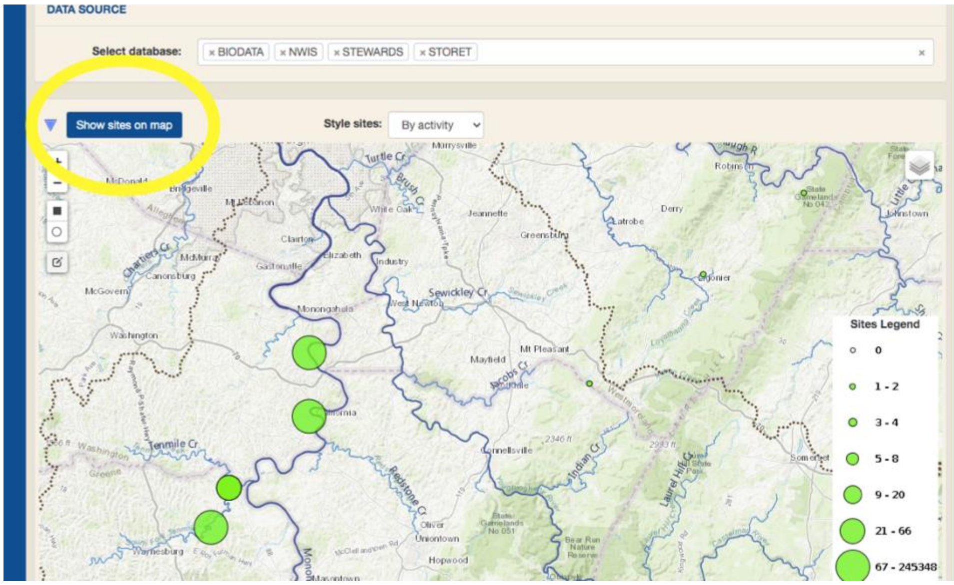
6. Type in the dates you want to search in mm-dd-yyyy format.



7. Under "Data source," select all available databases.



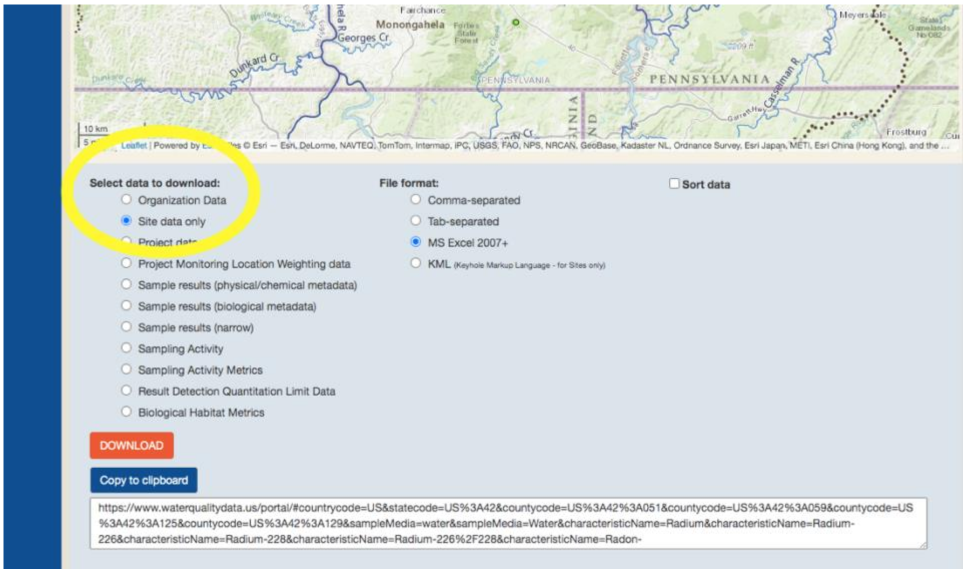
8. If you click “Show sites on map,” you can see a map of the sampling locations.



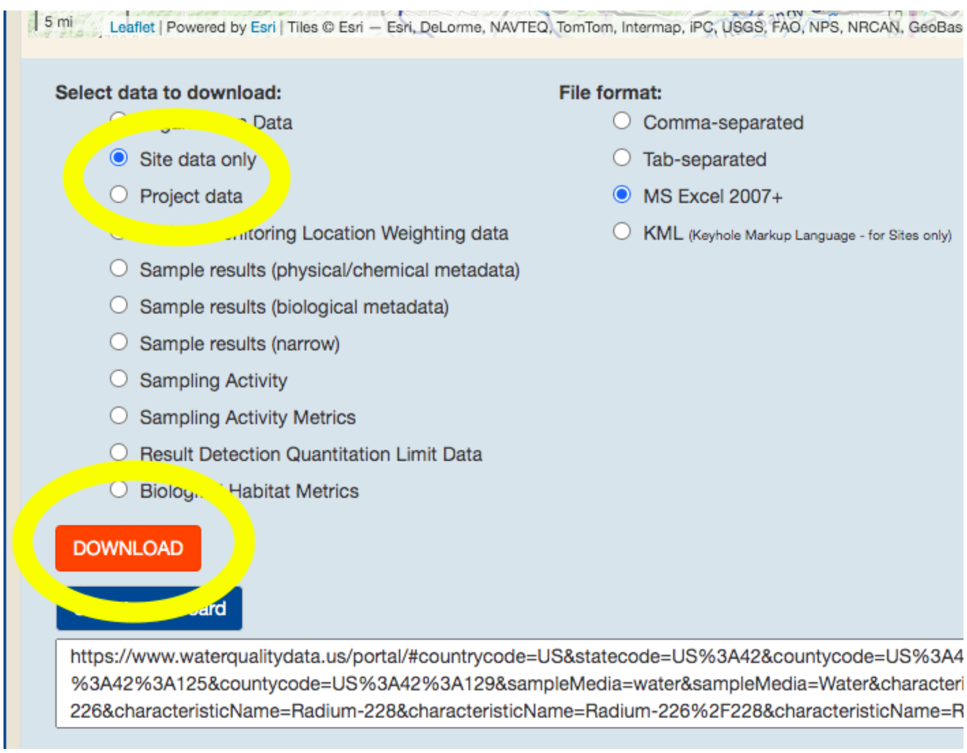
9. Next you can download and interpret the data!

Downloading and Understanding the Data: Surface Water

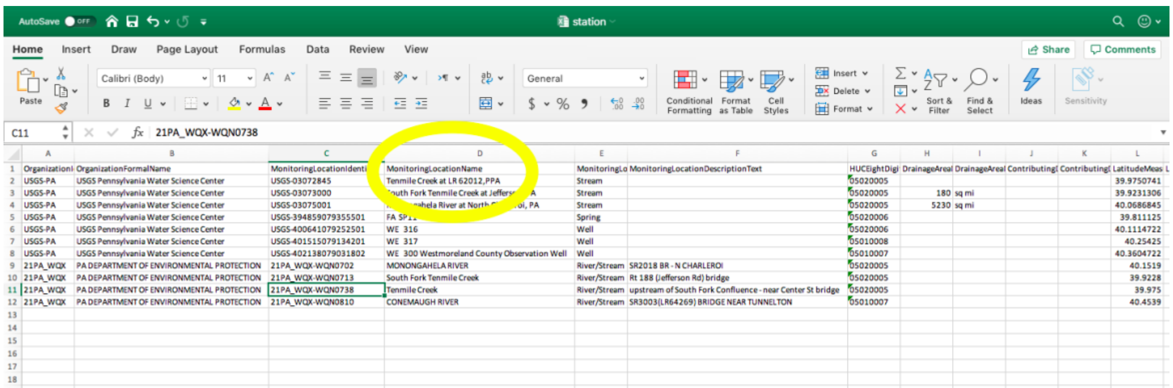
1. After you have filled in the parameters above, you will need to download two Excel files. Go to “Select data to download.”



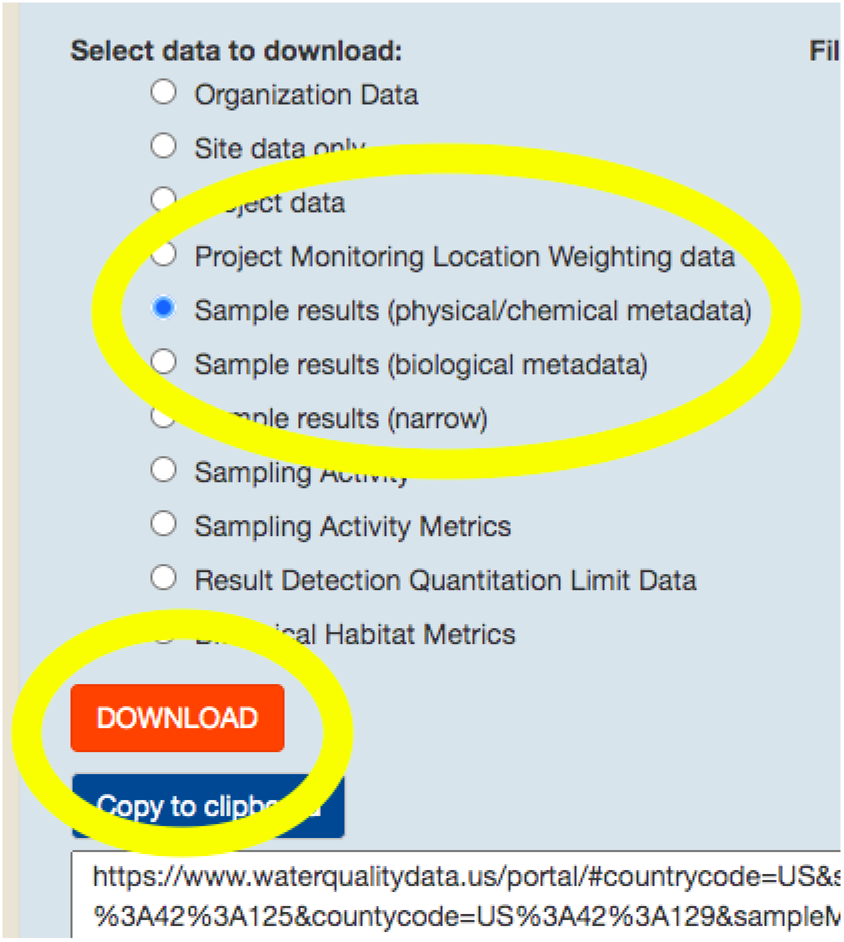
2. Click the button for “Site data only,” and then click “Download.”



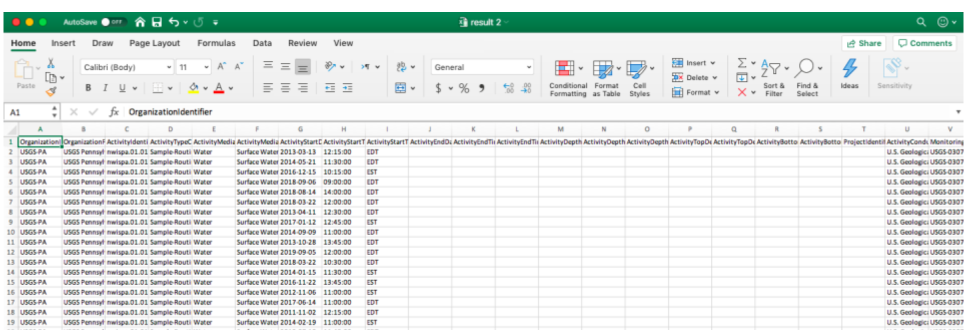
This will download an Excel file named "Station." The file will list information about the locations where samples were taken from, including what organization or agency collected the samples; whether the location is a stream, well or lake; and the name of the location. The "MonitoringLocationName" column will be necessary to interpret the results of the second Excel file.



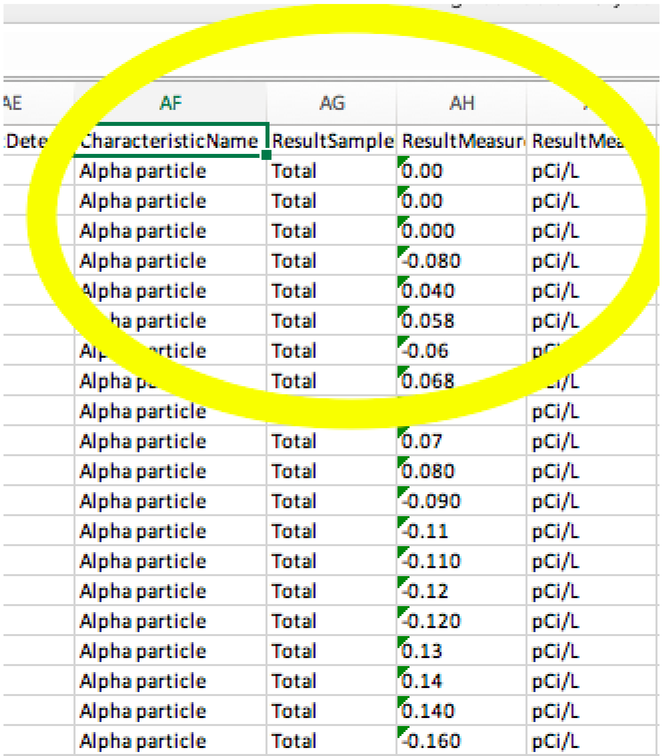
3. After downloading the site data, click the button that says "Sample results (physical/chemical metadata)." We do this because radium and alpha particles are chemical data. If we were looking for bacterial contaminants or information on water flow, we would select "Sample results (biological metadata)." Then click "Download" to download the second Excel file.



4. The second excel file, named "Results," has the results of radium tests and information about who conducted the tests.



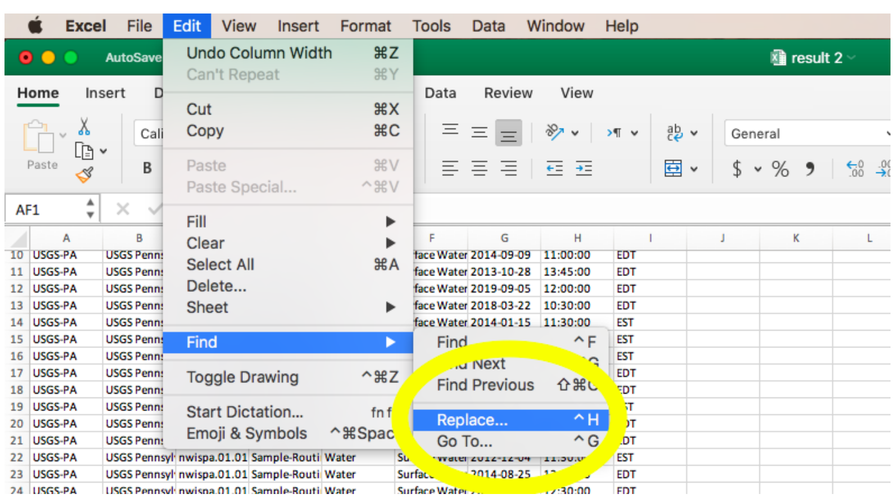
The numerical test results for radium sampling can be found in columns AF to AI.



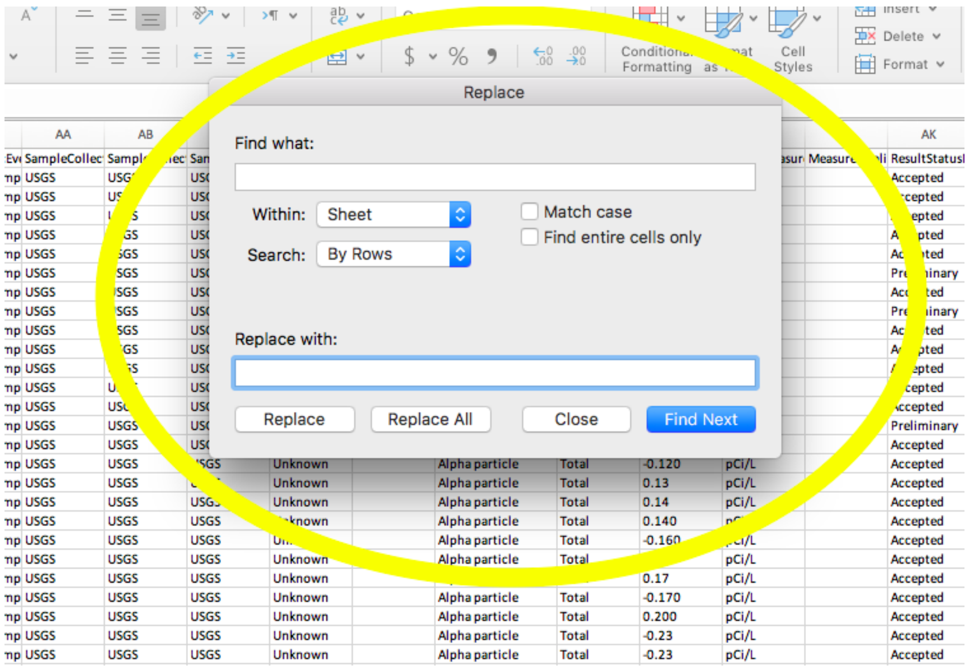
AE	AF	AG	AH	
Dete	CharacteristicName	ResultSample	ResultMeasur	ResultMea
	Alpha particle	Total	0.00	pCi/L
	Alpha particle	Total	0.00	pCi/L
	Alpha particle	Total	0.000	pCi/L
	Alpha particle	Total	-0.080	pCi/L
	Alpha particle	Total	0.040	pCi/L
	ha particle	Total	0.058	pCi/L
	Al rticle	Total	-0.06	p
	Alpha p	Total	0.068	/L
	Alpha particle			pCi/L
	Alpha particle	Total	0.07	pCi/L
	Alpha particle	Total	0.080	pCi/L
	Alpha particle	Total	-0.090	pCi/L
	Alpha particle	Total	-0.11	pCi/L
	Alpha particle	Total	-0.110	pCi/L
	Alpha particle	Total	-0.12	pCi/L
	Alpha particle	Total	-0.120	pCi/L
	Alpha particle	Total	0.13	pCi/L
	Alpha particle	Total	0.14	pCi/L
	Alpha particle	Total	0.140	pCi/L
	Alpha particle	Total	-0.160	pCi/L

5. To better understand the data, we recommend copying the location names from the "Station" Excel sheet and putting them into the "Results" sheet. This is because the data in the results sheet only includes codes for the locations—not the actual place names. See the steps below for instructions on how to replace the codes with the names in the results sheet.

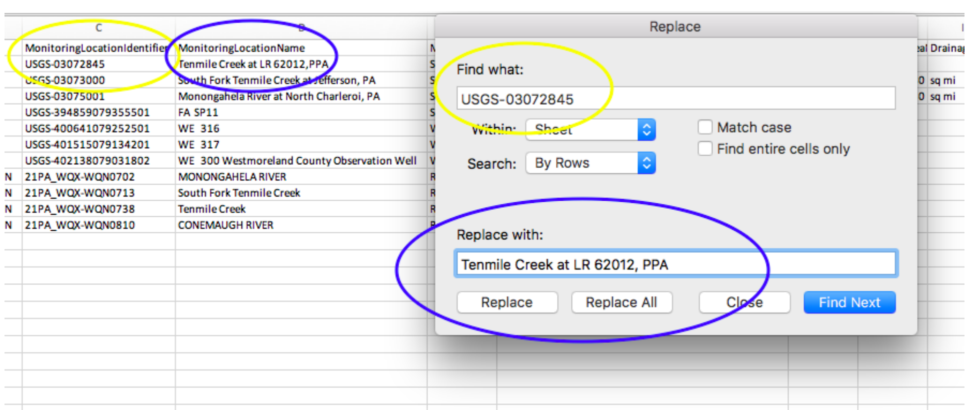
   a. Open the results sheet and go to edit > find > replace.



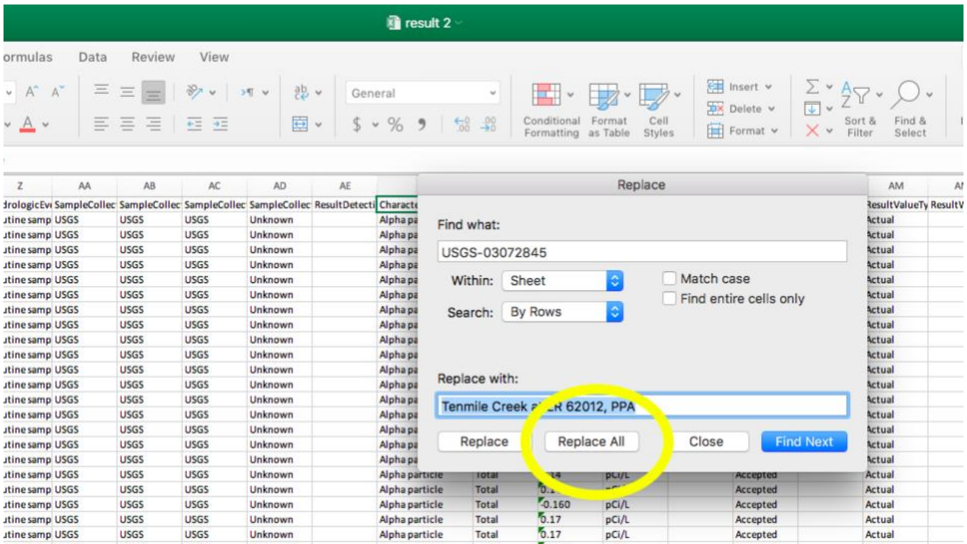
b. This will open up this window.



c. Then select the station sheet with the window still open. Type in the “Monitoring location identifier” under the find box and the “Monitoring location name” in the replace box.



d. Open the results sheet and hit "Replace all." This will replace all of the "USGS-03072845" cells in the results sheet with "Tenmile Creek at LR 62012, PPA," making it easier to read and understand.



e. Repeat this process for all locations.